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ABSTRACT

Not been much research has been done on the characteristics of adult learners of mathematics per se. In most cases, however, it appears that adult learners of mathematics share the characteristics of other adult learners. Adults are often good problem solvers, but they often need to be convinced that these methods are acceptable and applicable to math. Mathematics teachers working with adults must also be aware of the fact that many adults have learning histories with unusual gaps. Careful background assessments (not necessarily based on traditional methods) are therefore very important. Many adults have also developed a learning style that affects their approach to mathematics. For example, adults who lean toward a concrete experiential learning style will find the abstract quality of mathematics unnatural and will need to accommodate some of the structure of math while building on their strength as problem solvers. The following are techniques that have been found to be effective in teaching adults math: shared learning, sensitive diagnostics, integration, visualization, math as language, peer tutoring, and efforts to change past negative attitudes toward math. (MN)

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Mathematical Myths and Adult Learners

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Empire State College is part of the New York State University system (SUNY), but its method of delivery is rather unique. It was founded in 1971 to provide flexible alternatives for all residents of New York State for whom a nonresidential, individualized mode of education would be valuable. The majority of its students are adults (average age 37) who work full-time and find attendance at classes difficult, if not impossible.

At Empire State College, the primary mode of instruction is one-to-one. Faculty members are called mentors, because, in addition to working with students on specific subjects, mentors also act as advisors to aid the student in developing an individualized degree program. In addition, mentors access for the student resources from the community to help a student learn a particular subject. For example, a tutor may be hired to work with a student in telecommunications or computer graphics.

I work primarily with students in the area of Science, Math and Technology. Most of my students are in mathematics or computer science. I work with students at all levels- from introductory to advanced. Texts are carefully selected that are readable and provide good and frequent feedback, since the student uses the text as a replacement for attending lectures. They meet with me approximately every ten to fourteen days to go over their work and discuss problems they have encountered. Evaluation is based on worked-out problems and work done during our meetings.

It is from this framework that the observations and suggestions given in this paper are based.

To facilitate the leerning of mathematics, active learning is strongly advised. I encourage my student to engage with mathematics in an active way whenever they are working with it. Therefore, I ask that you pause a few minutes to consider the following problems. Here's the first one:

"It is 1988. Mary was born in 1949. How old is she?"

I have found that when I present this problem to a group, a wide variety of ways to solve the problem are volunteered. Some find the age for 1950 and then add one. People who are near that age use that as a comparison. Rarely does someone use the traditional "school method".

The purpose for presenting this problem is to emphasize that it is okay to use alternate methods for solving problems. Many of us discount a method because it is unlike one learned in school. We also tend to think that common sense has no value in solving math problems.

Try this one:

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TO THE EDUCATIONAL RESOURCES INFORMATION CENTER (ERIC)."

"Two pencils cost ten cents. How much do three pencils cost?"

One possible answer is fifteen cents. However, this would only be true if each of the other two pencils cost five cents. What if one pencil cost seven cents and the other one three?

The purpose of this problem is to emphasize the fact that many problems are ambiguous. We need to carefully state assumptions made before giving a solution, since the solution may differ depending on the assumptions. "Correctness" will be judged on the basis of reasonableness of assumptions made. This goes against some assumptions we have made about mathematics. I will discuss this point later.

Characteristics of Adult Learners

Much research has been done on the characteristics of adult learners, although not specifically on characteristics of adult learners of mathematics. In most cases, it appears that the general characteristics do apply to the learning of mathematics.

Knowles, in his theory of androgogy (Knowles, 1980), speaks most eloquently on characteristics of adult learners. He refers to them as self-directed, with a greater volume and different quality of experience. He speaks of them as having internal motivation and a problem-centered orientation. Patricia Cross moves from these characteristics to the need of adults to share in decisions about how they shall learn. She observes that adults have a pragmatic approach to learning and want to apply knowledge to life goals. She also refers to their reservoir of life experiences (Cross, 1979).

Adult learners of mathematics share these characteristics. They have a reservoir of life experience. Unfortunately, for many, these past experiences have been negative ones. This may have reduced their confidence in their ability to do mathematics. Many adults engage in self-defeating self-talk (Tobias, 1978), through which failure is expected and attributed to lack of ability. Even success may not increase confidence, since the adult may just attribute that to luck. Some adults believe that they missed an important aspect of math in the early years and can never retrieve what they need.

Yet, adults are often good problem solvers. They have developed over the years methods for solving problems encountered. They often need to be convinced that these methods are acceptable and applicable to "math".

One characteristic of adults that needs to be considered carefully when working with them in mathematics is that they may have involved learning histories with unusual gaps. Many have not studied math formally for over twenty years. However, because of work requiremments, they may have acquired a good understanding of some of the topics. Unusual gaps may exist, however. I've had students who understand calculus but have problems with fractions. I had one student who could do computability theory and linear algebra, but who had never learned trigonometry. Assessment of background must be done carefully and traditional methods may not be appropriate.

Adults also have a developed learning style (Kolb, 1984) which does affect their approach to mathematics. In addition, knowledge of one's learning style may assist in the developing of appropriate learning strategies. For example, adults who lean toward a concrete experiential learning style will find the abstract quality of mathematics unnatural and will need to accomodate to some of the structure of math while building on their strength as problem solvers. They will also want to engage in discussions of mathematics, since this is preferred to learning from a text. Those leaning toward active experimentation will need to focus on practical appplications and active learning.

Adults also have developed preferences for taking in information (audio vs visual and linguistic vs quantitative). Some really learn best by hearing the information, while others prefer to read it. Some learn best through words: others through symbols. None of us are entirely one way or another, but being aware of preferences can make learning easier.

Many have spoken of the pragmatic approach or problem-centered orientation of adults. This applies to the learning of mathematics as well. Adults are less capable of learning isolated and unrelated facts. They are integrated learners and learn best if they can connect new concepts to former ones. For example, for an adult who has used math in electronics, expanding his knowledge of math through electronics applications will help significantly. One adult confessed to me that problems involving money were much easier to solve.

Now that some characteristics of adult learners of math have been presented, let's look at some mathematical myths. I will begin with a discussion of the different views of mathematics.

Different Voices of Mathematics

Given their characteristics, some adults do have problems learning mathematics. Past experiences have given them a view of math that is quite negative, making math unapproachable. Some have learning styles and strategies that are incompatible with the way math is traditionally taught. Let's take a look at some common views of mathematics.

I need to actually begin with cognitive theory, specifically with some of the work of Perry (1970). Perry spoke of adult development as a passing through a series of stages. In an early stage of dualism, the person divides reality into two realms: good versus bad; right versus wrong with the right answer existing somewhere for every problem. Later, the person is able to view the world more relativistically, where all knowledge and values are contextual or relativistic with more dependence on internal judgement rather than external authority and there is a willingness to consider alternatives.

Carol Gilligan (1982) also made some observations about thinking that have applications to the teaching and learning of mathematics. She discussed the concept of separate versus connected reasoning. When using separate reasoning, a person gets right to the solution in a structured, algorithmic way, stripping away all context. He uses a mode

of thinking that is abstract and formal. The connected thinker tries to experience the problem, relate it to the personal world, clarify language and remove ambiguity. She uses a mode of thinking that is contextual and narrative and is geared to looking at limitations of any particular solution and describing the conflicts that remain.

What does all this have to do with the learning of mathematics? Dorothy Buerk (1985) has applied these theories and found them very helpful in understanding adult learners of mathematics. She found that the adults she studied often had a dualistic view of mathematics, in which math is perceived as rigid, removed and aloof rather than one that is being discovered and developed. Math is seen as a collection of answers rather than a dynamic process that is active and changing. Math is also perceived as a collection of facts separate from one's own thought processes. These perceptions lead to a feeling of helplessness and low interest in mathematics.

Teachers of adults need to be aware of these attitudes and how this dualistic view is often very different from the adult's view of other areas, such as morality. Once the incongruity is acknowledged, the adult is often able to develop a different view of mathematics.

Often, however, math is taught in a way that reinforces this viewpoint. The separate reasoning identified by Gilligan is often the prevailing view in the classroom, where the solution has primary importance (rather than process) and context is quickly stripped in favor of an abstract approach. Many adults, however, are more comfortable with connected reasoning. We need to consider carefully how we teach mathematics, therefore.

Implications and Suggestions

What are the implications of the ideas presented above? These will be integrated into the following suggestions:

--shared learning: Adults need to be respected as learners. Given their low confidence in math, this is especially important. It may help to discuss aloud the process you are using as you solve a problem, to demonstrate that mistakes are not fatal and can actually be learned from. This will help the tentative learner become more willing to risk, since both "teacher" and "learner" can make mistakes.

--sensitive diagnostics: I mean this in two ways. First of all, it should be as non-threatening as possible. Results should be discussed carefully so that negative attitudes are not reinforced. In addition, the diagnostics should try to identify unusual gaps and strengths. For example, I would not recommend an algebra pre-test for someone who has has no formal math in the past twenty years. A test of general problem-solving skills may identify some unexpected strengths, however. Tests of spatial visualization and field dependence may also be of interest.

--integration: Adults need to be presented material in context so that they connect it to their own experience. Drill and practice will rarely

work if stripped of context. An historical approach often helps make some of these connections.

--math as language: I have found that many adults relate well to the analogy of math as language. Symbols and rules need to be learned as with any language. This also encourages them to be patient with themselves, since they wouldn't expect to learn French or Spanish in a day. This also helps them see math as a system, where many of the rules exist so that results are consistent. Algebra, as the basic language of mathematics, becomes more meaningful and approachable.

--visualization: If at all possible, I encourage my students to draw a picture. Some believe that this is a sign of weakness or for some reason not allowed. A picture often allows for connections to be made and is an excellent technique for problem-solving.

--learning styles: Many learning style inventories are available. Adults often are unaware of their learning style and do find it helpful to assess their preferences. Often, it helps them set up a study plan that aids learning and reduces frustration. Discussion of study habits is entirely appropriate and recommended.

--text selection: I look for texts that give thorough explanations with lots of examples. Books that are mostly examples are to be avoided, since they are either too cook-bookish or dependent on lectures to give the background for methods used in the examples. I also look for careful use of vocabulary and definitions. Words should be more in use than symbols, since most adults learn best through words rather than symbols.

--peer tutoring: Adults understand each other. We have a resource center with peer tutors and it works very well.

--attitude: I find attitude to be a good predictor of success. If someone enjoys math, he or she will persist in it and be able to endure the frustrating moments. Math can be fun and I try not to get too serious about it. The enthusiasm is contagious!

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(This article is based on a talk given on October 7, 1988 at the Adult Education Conference in Cincinnati, Ohio).

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